



A Rule Based Neuro-Fuzzy Expert System Model for Diagnosis of Diabetes

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Abstract: In the field of artificial intelligence, neuro-fuzzy system is a combination of artificial neural networks and fuzzy logic. Diabetes is a serious, life-threatening, chronic disease which occurs when your body does not produce enough insulin or cannot use the insulin it produces. Identifying the disease accurately depends on the method that is used in diagnosing disease. An enhanced approach for diagnosis of diabetes is to create an expert system with Artificial Neural Networks that has artificial intelligence characteristics. There are number of approaches available. One such approach is by the use of a combination of rule based, neural networks and fuzzy logic to create a Neuro-Fuzzy Expert System (NFES). By means of NFES, diagnosis of diabetes becomes simple for medical practitioners/physicians. This paper will discuss the design & proposed model involved in creating such a NFES system to diagnose diabetes.

Keywords: Neuro-fuzzy system, Fuzzy logic, feed forward architecture, Expert System, Diabetes

I. INTRODUCTION

Diabetes is a major rising health problem in all over the world especially in India. It causes ill health to the human and making them early death. Diabetes is a chronic disease which occurs when your body does not make enough insulin or cannot use the insulin it makes. Recent trends in research develop expert system day to day especially in the field of medical diagnosis. Expert is the emerging technology in Artificial Intelligence. Artificial Neural Network is the mathematical model of the human neural network. Modern neuro-fuzzy systems are usually represented as a special multilayer feed forward neural network [3].

This research work proposes the diagnosis of the diabetes mellitus using Neuro-fuzzy expert system by means of feed forward neural network architecture. The data set of the diabetes includes age, pregnancy, diabetes in the family, body mass index, Cholesterol, 2-h serum insulin, pedigree of diabetes. These cells are used as input parameters for the fuzzy logic system. The input crisp values which are to be fuzzified. On the basis of fuzzy rules, the linguistic variables are then collected by means of rule based inference engine. The outputs are collected by means of defuzzification method. The output describes whether disease is probably normal or abnormal.

The frame work of this paper consists of: Section-2, which describes the Literature Survey, section 3 explains about an overview of diabetes, an overview of neuro-fuzzy logic Expert System is given in section 4, Section 5 describes proposed model for disease diagnosis, section 6 includes conclusion.

II. LIRETATURE SURVEY

Faran Baig , Dr. M. Saleem Khan ,Yasir Noor ,M. Imran described Fuzzy logic uses different vocabulary in itself, i.e fuzzification, defuzzification, membership function, linguistic variables, domain, rules etc. In Boolean algebra or Boolean logic crisp sets are used, which has only two values 0 and 1, but in fuzzy logic sets have infinite logic values between 0 and 1, in Boolean logic completely inclusive, exclusive membership is used, but in FL completely

inclusive, exclusive or between these two membership is used [1].

Oguz Karan a, Canan Bayraktara, Haluk Gumus_kaya b, Bekir Karlık c proposed three-layered Multilayer Perceptron (MLP) feed forward neural network architecture and trained with the error back propagation algorithm. The back propagation training with generalized delta learning rule with an iterative gradient algorithm is designed to minimize the root mean square error between the actual output of a multilayered feed-forward neural network and a desired output [2].

P.K.Dah , A.C.Liew,S.Rahman explains about an adaptive fuzzy correction scheme is used to forecast the final output by using a fuzzy rule based and fuzzy inference mechanism.[6]

Scott S. Lancaster et al. described about the design of Fuzzy logic controller (FLC) for medical device based on software using fuzzy logic. FLC used for controlling the regulator to apply air pressure to the skin of human consisting of analogue-to-digital convertor for the collection of data, pneumatic valve and sensor to control air pressure [8].

Ch. Schuh et al. discussed about how fuzzy logic used in medical human health care system and the medical data of patient [9].

He Yue , Guo Yue and Guo Yi et al. discussed about the immune system that protects the human body, on the basis of the immune algorithm using a flow chart and Fuzzy Cognitive Map (FCM) [10].

Yataka Hata , Syoji Kobashi and Hiroshi Nakajima et al. explained about the management system for human health care and worked on the scheme to concentrate medical diagnosis and health management [11].

Supriya Kumar De, Ranjit Biswas and Akhil Ranjan Roy et al. described to extend the research and using the idea of intuitionist fuzzy set theory and introduced the case study of some patients, collected the data of their symptoms and used this data in IF theory and given results in tabular form [12].

M. Mahfouf , M.F.Abbod , D.A.Linkens et al. proposed about the fuzzy logic in the neuro medical field, fuzzy logic evaluation on the basis of facial expression and surveyed different fuzzy techniques using the data analysis of medical science [13].

Christian J. Schuh et al. proposed a survey related to the fuzzy logic, fuzzy sets and relations and fuzzy control and their application in medical science and explained Gluco Notify patient glucose data setting, fuzzy automata concept for ARDS therapies [14].

III. OVERVIEW OF DIABETES

According to “IDF Diabetes Atlas”, about 1 million people died from diabetes in India in 2012. Diabetes is affecting the people all over the India both in rural & urban areas. Diabetes mellitus is due to inadequate insulin production or need of responsiveness to insulin, resulting in hyperglycemia.

There are three types of diabetes. Type 1 diabetes, Type 2 diabetes, and Gestational diabetes.[4]

3.1. Type 1 Diabetes

It was earlier called as insulin-dependent diabetes mellitus .There are less Risk factors for type 1 diabetes when compared to type 2 diabetes. There is an involvement of Genetic and environmental factors in the growth of this type 1 diabetes.

3.2. Type 2 Diabetes

It was earlier called as non-insulin-dependent diabetes. The Risk factors of type 2 diabetes are older age, obesity, family history of www.aasrc.org/aasrj American Academic & Scholarly Research Journal Vol. 4, No. 5, Sept 2012.

3.3. Gestational Diabetes

It develops in the time of pregnancy but disappears when a pregnancy is over. Gestational diabetes mellitus (GDM) is characterized by carbohydrate intolerance of varying severity with onset or first recognition during pregnancy. Women with a history of GDM are at increased risk of future diabetes, predominantly type-2 diabetes, as are their children.

IV. OVERVIEW OF NUERO-FUZZY EXPERT SYSTEM

Fuzzy logic is a superset of Boolean logic that has been truth values between true and false. Fuzzy logic is a rule based system that uses IF-THEN rules and human-like uncertainties. Instead of using Boolean 0 & 1, it uses a floating point value between these two extremes. The main strength of neuro-fuzzy systems is that they are universal approximators with the ability to seek interpretable IF-THEN rules.

The strength of neuro-fuzzy systems involves two contradictory requirements in fuzzy modeling: interpretability versus accuracy. In practice, one of the two properties prevails. The neuro-fuzzy in fuzzy modeling research field is divided into two areas: linguistic fuzzy modeling that is focused on interpretability, mainly the Mamdani model; and precise fuzzy modeling that is focused on accuracy, mainly the Takagi-Sugeno-Kang (TSK) model.[5]

Compared to a common neural network, connection weights and propagation and activation functions of fuzzy neural networks differ a lot. Although there are many different approaches to model a fuzzy neural network (Buckley and Hayashi, 1994, 1995; Nauck and Kruse, 1996)[5].

A neuro-fuzzy system based on an underlying fuzzy system is trained by means of a data-driven learning method derived from neural network theory. It can be represented as a set of fuzzy rules at any time of the learning process. Thus the method might be initialized with or without previous knowledge about fuzzy rules.

V. PROPOSED NUERO FUZZY MODEL FOR DIAGNOSIS:

The present work proposes fuzzy neural network model based on multilayer perceptron using back propagation algorithm by including fuzzy logic & fuzzy sets at various stages. Fig1. Shows the proposed fuzzy neural network model. The input parameters includes age, pregnancy, diabetes in the family, body mass index, Cholesterol, 2-h serum insulin, pedigree of diabetes.

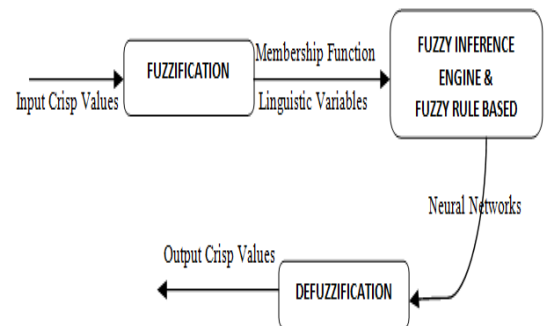


Fig 1: Proposed Fuzzy Neural Network Model

From the above Fig1 the input crisp values are fuzzified into linguistic variables by means of membership functions. These linguistic variables are modified by fuzzy ruled based inference engine. Here we use 4 layer feed forward algorithm for solving the practical problems accurately. The linguistic terms are converted to crisp output values by defuzzification method.

Fuzzification: It is a procedure by which the crisp inputs are classified to equivalent linguistic terms which constructs membership functions. This method will convert a crisp input value into a fuzzy set or fuzzy singleton.

Fuzzy Inference Engine & Fuzzy rule Base: This section contains the input linguistic variables which are modified by means of fuzzy rule-based inference system. The fuzzy inference algorithm implements fuzzy IF-THEN rules in a huge field of realistic problems by means of neural network multi layer feed forward algorithm. Fuzzy rules can be generated by the expert knowledge using AND/OR connectives.

Defuzzification: Defuzzification is the opposite process of Fuzzification, in which, the output linguistic terms are converted into crisp values. The Defuzzification process can be as per the requirements of the problem. The centre of sums method is used in defuzzification process.

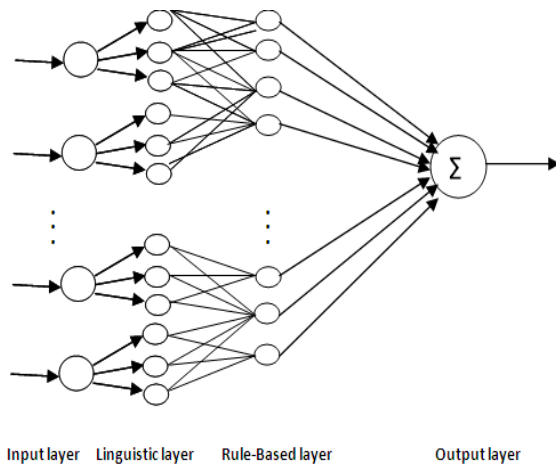


Fig2: Neuro-Fuzzy Feed Forward Architecture

Figure 2 shows four layered architecture as given below:

Input Layer: The first hidden layer i.e., input layer is responsible for the fuzzification of each input variable. Each node represents a simple Membership Function (MF) or a composed multilayer node represents complex MF.

Linguistic Layer: The Second hidden layer i.e., linguistic layer which stores the linguistic values of all the input variables. Each input unit is only connected to those units of the input layer, which represent its linguistic values.

Rule based Layer: The third hidden layer i.e., rule based layer represents the fuzzy rules nodes. This layer is used for computing rule outputs. It needs a crisp output from each rule.

Output Layer: Output layer work out all the inputs as the summation of all incoming signals.

VI.CONCLUSION

Diabetes is a major rising problem in all over the world. In our proposed work, the paper presents neuro-fuzzy expert system for diagnosis of diabetes to get accurate results. As mentioned before, there are many research studies in the area of diabetes. The paper presents the study of previous work in many aspects. In this paper we mentioned about the combination of Artificial Neural Networks and fuzzy System by using feed forward neural network architecture for diagnosing the diabetes disease.

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